THE EFFECTS OF MANAGEMENT CONTROLS AND NATIONAL CULTURE ON MANUFACTURING PERFORMANCE: AN EXPERIMENTAL INVESTIGATION*

CHEE W. CHOW
San Diego State University

MICHAEL D. SHIELDS
San Diego State University

and

YOKE KAI CHAN
*Nanyang Technological Institute
Singapore*

Abstract

The increasing dominance of Asian manufacturing firms in the global economy has raised an important issue: whether these firms' superior manufacturing performance is caused by their management control systems, the national culture of their employees, or the interaction of these two factors. This experimental study provides a direct test of the effects of national culture and management control system on manufacturing performance. The dimension of national culture studied was individualism (vs collectivism) because this work-related attribute has been noted as a major difference between Asian and Western cultures. In turn, the focus on cultural individualism motivated a study of two aspects of management controls: work flow interdependence and pay interdependence. The results are consistent with cultural individualism and management controls having independent, but not interactive, effects on manufacturing performance. The potential implications of these findings and suggestions for future research are discussed.

The globalization of the world economy has greatly increased manufacturing firms' concern with maintaining their competitive advantage. In the U.S.A., considerable attention has been focused on that country's declining competitiveness in manufacturing (Hayes & Abernathy, 1980; Hayes *et al.*, 1988; Skinner, 1985). Critics have attributed this situation, in part, to U.S. firms' management control systems (Hayes & Abernathy, 1980; Hayes & Wheelwright, 1984; Johnson & Kaplan, 1987; Kaplan, 1983, 1984). In the meantime, firms from the Asian countries have become increasingly dominant in many segments of the world market. This development has prompted U.S. academics and businesses to study the Asian firms' management control systems, with a view towards transplanting such systems to U.S. firms.

The success of many Asian manufacturing firms is due in part to their producing superior quality products at a lower cost. However, an issue that remains unresolved is whether this manufacturing performance is the result of these firms' management controls, the national

culture[1] of their employees, or the interaction of these two factors. Resolution of this issue has important implications for the design of management control systems. If national culture or the interaction of national culture and management control is a primary determinant of performance, then there may be little benefit from emulating the management controls of firms that operate in a country with a different culture. On the other hand, if performance is mainly affected by the management control system, then adopting a system that has succeeded in another country may hold more promise.

To date, no empirical study has directly tested the effects of national culture and management control system on manufacturing performance.[2] The objective of this study is to conduct some such tests structured by five hypotheses. The controlled setting of a laboratory experiment is used because it offers the advantages of high internal validity, measurement precision and accuracy, repeatability and control over omitted variables.[3] (The method section discusses specific issues related to the effectiveness of laboratory experimentation and other research methods in studying the effects of national culture.) The results are consistent with cultural individualism and the management control system having significant independent, but not interactive, effects on manufacturing performance. If these results are replicated by future research, then an implication is that the management control systems used by Asian firms may also be used by non-Asian firms to improve their performance.

The remainder of this paper is organized as follows. The next section provides a review of the related literature as the basis for developing five hypotheses. Then the experimental method is explained and the results of the hypothesis tests are presented. The final section provides a summary and discussion.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Explanations for manufacturing performance

The extant literature on the determinants of manufacturing performance provides three explanations of the Asian firms' superior performance.

National culture

At one extreme is the explanation that the Asian firms' superior manufacturing performance is primarily attributable to the national culture of their employees and the design of management control systems based on that culture (Cole, 1979; Ouchi, 1981; Pascale & Athos, 1981). This explanation is consistent with the contingency theory of organizations (Hall, 1987), which proposes that organizational structure is dependent on organizational context, and that context and structure interactively affect performance. While contingency studies have generally focused on the relationship between organizational structure (e.g., centralization, formalization of rules) and such organizational context variables as uncertainty, technol-

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[1] Many definitions of corporate and national culture have been proposed (Adler et al., 1986; Frost et al., 1985; Hofstede, 1980; Schein, 1985). Similar to Hofstede (1980), culture is defined here as the common mindset about beliefs, values and goals that distinguishes one group from another.

[2] A voluminous literature in psychology and sociology exists on various aspects of culture and their relations to behavior (e.g. cognition, socialization, personality development, values, beliefs, and motives). Excellent reviews of this literature are available in Triandis and Brislin (1980) and Segall (1986). Segall (1986) observes that by and large, studies on cultural values and motives have been descriptive, with little analysis of either their determinants or consequences. He especially notes a lack of experiments that bear directly on ways to stimulate achievement-oriented behavior. Our search of this literature failed to reveal any experimental study on how culture and the management control system affect manufacturing performance.

[3] A major disadvantage of laboratory experiments, as compared to other methods (e.g. field studies), is reduced external validity. However, since research in this area is in its infancy, we consider the advantages of laboratory experimentation to out-weigh its disadvantages. We readily acknowledge the need also to apply other research methods to the issues discussed in this study.

ogy and competition, national culture may also be an important organizational context variable that drives organizational structure.

It has been observed, for example, that Japanese culture is characterized by a group (or collective) — as opposed to individual — orientation (Reischauer, 1977; Richardson & Veda, 1981; Schein, 1981; Smith, 1983). It is posited that members of a collective culture view self development as occurring through harmony and reciprocity in interpersonal relations and contributing to the welfare of other group members (e.g. clan, work team). The collective orientation of Japanese culture, in turn, has been suggested as the basis for such oft-cited Japanese management approaches as teams, participative decision making and quality circles (Lincoln & McBride, 1987). In contrast, members of an individualistic culture, such as the U.S., are less ready to take actions solely for their positive effects on other members of the group (Hofstede, 1980). Thus, many of the controls frequently used by U.S. firms (e.g. individual piece rate pay, responsibility accounting) stem from an individualistic approach to social organization and work.

To date, direct tests of whether national culture and management controls jointly affect manufacturing performance have yet to be reported. However, research using field survey or field study methods has provided indirect support for the notion that national culture affects the effectiveness of alternate management controls. Both Daley et al. (1985) and Birnberg and Snodgrass (1988) have found differences between U.S. and Japanese employees' attitudes towards various components of a management control system. Child (1981) has provided a review of contingency theory-based studies in several countries. He notes that while similarities exist across countries in the context-structure contingencies, there remains considerable variation across countries that these contingency theory variables cannot explain. Several empirical studies of Japanese and Western (primarily British and U.S.) firms have found

similar context-structure contingencies among them, though the Japanese firms tended to have different structures (Lincoln and McBride, 1987). This finding is consistent with national culture being a potential omitted variable in designing management controls. However, none of these prior studies had included national culture or its components as an organizational context variable.

Manufacturing strategy and control

At the other extreme is the explanation that the Asian firms' superior manufacturing performance is primarily due to their use of specific manufacturing strategies and control systems (e.g. just-in-time/total-quality-control (JIT/TQC)) [Hall, 1983; Hayes, 1981; Hayes & Wheelwright, 1984; Schonberger, 1986]. Two experimental studies have provided partial tests of this explanation.

Huang et al. (1983) conducted computer simulations of a multiline, multistage "push" production system with JIT kanbans.[*] The dependent variable was performance, measured as the total time to produce a given output, WIP inventory levels and total production per regular production day. The manufacturing control system was varied by manipulating the number of production kanbans allowed. Huang et al. (1983) also proxied for different production contexts by varying the shape, mean and variance of the processing times for each production stage and the shape and variance of the demand distribution. The results were consistent with their expectation that interaction effects exist between the manufacturing control system and each of the context variables.

While Huang et al. (1983) focused on engineering proprerties, Young et al. (1988) allowed for human motivational effects by means of a laboratory experiment using U.S. subjects. The independent variables in their study were the inventory control system (push vs pull), the quality control system (process vs output) and the compensation system (perform-

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[*] A kanban is a paper-based inventory flow system that controls the timing and quantity of production and WIP at each work station along an assembly line. A detailed discussion of kanbans is available in Monden (1983).

ance contingent vs fixed pay). The dependent variables were production effectiveness and efficiency. Consistent with their five hypotheses, Young et al. (1988) found that both performance effectiveness and efficiency were interactive functions of the inventory and quality control systems and independent functions of the compensation system.

Thus, both of these prior studies have found controls used by Asian firms to affect manufacturing performance in predicted directions. However, since neither study included a culture manipulation, they are unable to examine its effects on performance.

National culture, strategy and control

The third explanation of the Asian firms' superior manufacturing performance represents a compromise between the other two explanations. It acknowledges the importance of national culture to management controls while arguing for the selective adoption of the Asian firms' management approaches (Abegglen & Stalk, 1985; Pegels, 1984; Sethi et al., 1984; Weiss, 1984). As such, it posits that national culture and management controls have both independent and interactive effects on manufacturing performance.

No direct empirical test of this third explanation has yet been reported, though it has received some indirect support from field research findings. Horovitz (1980) examined how the top managements of British, French and German firms viewed and applied management controls. Even though these firms can be presumed to have national cultures that are more similar to each other than to those of the Asian countries, he still found differences among them. Along the same vein, Kreder & Zeller (1988) have reported the use of different control systems in German and U.S. firms. Another indication that national culture and management controls may have independent performance effects is that while some U.S. firms have experienced success, others have experienced failure, in adopting such Asian management practices as teams, quality circles and consensus decision making

(Ansberry & Sasaki, 1985; Bryne, 1986; Levin, 1985; Schonberger, 1986; Sease, 1985).

Limitations of prior research

The preceding review indicates that extant research has shed some light on the potential roles of, and relationship between, national culture and management controls. However, for purposes of designing management controls, these prior studies are limited by the lack of direct tests on whether national culture and management controls independently or interactively affect performance. Furthermore, these studies have been primarily descriptive. Except for Birnberg and Snodgrass (1988), they have focused on detecting national differences without addressing which specific national attributes (e.g. culture, the political system, the economic climate) may account for these differences. They have also dealt only with general (e.g. delegation, formalization), rather than specific, characteristics of management control systems. In conjunction with their lack of analysis of nation-specific attributes, their findings cannot address which particular management controls (e.g. fixed vs performance-contingent pay) may be nation-specific, and which may be generally applicable.

Given that the theoretical and empirical literatures are not sufficiently developed to resolve whether manufacturing performance is a function of management controls, national culture or their interaction, direct tests of these effects would seem to be desirable. Below, five hypotheses about the effects of national culture and management control on manufacturing performance are developed to guide this exploratory study. To facilitate presentation of these hypotheses, the operationalization of national culture and management controls in this study is first explained.

Cultural individualism–collectivism

Experimentally testing the many proposed dimensions of national culture is beyond the scope of this study. We focused on individualism because the Asian and Western cultures are held to be particularly divergent on this work-related

attribute (Abegglen & Stalk, 1985; Adler *et al.*, 1986; Dore, 1973; Hofstede, 1980; Richardson & Veda, 1981; Sethi *et al.*, 1984; Smith, 1985). In a survey of some 80,000 workers from over 70 countries, Hofstede (1980) found that the U.S. and the Asian countries occupy opposite poles of this dimension. On a 0–100 scale, the U.S. workers had the highest mean score of all the countries (91). The Japanese workers' mean score (46) was slightly below the overall mean (51); much lower means were obtained for workers from Hong Kong (25), Singapore (20), Thailand (20) and Taiwan (17). Indeed, Hofstede (1980) has stated that, given the importance of individualism as a determinant of behavior, many U.S. management practices may be inappropriate for other countries. Conversely, management practices that suit a group-oriented culture may be inappropriate for U.S. firms.

Interdependence in control systems

Focusing on individualism led us to select for study the degree of interdependence across responsibility centers (e.g. individual employees, departments or divisions). This choice is based on the premise that the effectiveness of a management control system is likely to depend on the "fit" between the interdependence that it induces and the employees' individualism. Thompson (1967) has provided an analysis of three forms of interdependence at the department level regarding the division and flow of work. The simplest is pooled interdependence in which little, if any, work flows between departments. At the individual worker level, this form of interdependence is analogous to each worker having complete control over the work necessary to transform inputs to outputs. Sequential interdependence involves a serial link between departments, with the output of one department being the input to the next department. This situation is analogous to an assembly line (either push or pull). The third form of interdependence is reciprocal, in which resources or information move back and forth between departments. Extant research applying

Thompson's framework to departments indicates that the effects of management controls depend on the form of interdependence (Chenhall & Morris, 1986; Hayes, 1977; MacIntosh & Daft, 1987; Merchant, 1985).

Work flow interdepedence is one of two types of inter-worker interdependence examined in the study. Drawing on Thompson's framework, pooled interdependence (i.e. independent work flow) occurs when each worker is able and responsible for performing all of the work necessary to make a unit of output. Sequential interdependence (i.e. dependent work flow) occurs when each worker is able and responsible for performing a specific part of the work necessary to make a unit of output.

The second type of interdependence examined is the incentive pay contract. Prior analytical and experimental research have indicated that the pay contract has a significant impact on performance (Baiman, 1982; Chow, 1983; Waller & Chow, 1985; Demski & Feltham, 1978; Young *et al.*, 1988). Since the two work flow conditions differ in how each worker's effort translates into units of output, the way that such output is measured and paid for can significantly affect workers' effort incentives. To examine how the fit between work flow and pay interdependence affects performance, two types of pay interdependence are used. With independent pay, each worker is paid according to his or her own output. In contrast, each worker under dependent pay is paid based on his or her work group's output.

Crossing the two types of work flow with the two pay systems yields four types of control system-induced interdependencies. Within this context, the three explanations of the Asian firms' superior manufacturing performance yield different predictions of performance effects. The first explanation predicts only a significant interaction effect among cultural individualism and the two types of control system-induced interdependencies. In contrast, the second explanation predicts only a significant main effect due to the control system. Finally, the third explanation predicts both main and interaction effects due to cultural individualism

Experimental procedure

The two-hour experimental session involved the same steps at each research site.

1. The experimenter read through a written script which described the experiment as involving issues in management without providing any further elaboration. Then the nature of the translation task was explained. After this, each subject was given a translation key and told to translate two rows of ten triplets provided on a separate sheet.

2. After all subjects had completed the two rows, they were shown the correct translations. When all subjects indicated that they understood the task, each was given three sheets containing ten rows of ten triplets each. The subjects were told to write their names on these sheets and to translate as many triplets as they could (in the order given) in a 15 minute training period. This performance was used as the measure of each subject's PC.[8] While the subjects were not paid for this work, participation was a prerequisite for retention in the paying part of the experiment.

3. Each subject's sheets were collected to determine the number of triplets that he or she had correctly translated. While this was in progress, the subjects completed an interim questionnaire which included demographic questions and questions from Hofstede's (1980) culture instrument related to individualism (discussed below).

4. The work groups were formed by assigning the subjects with the three highest PC scores to

the first group, the next three to the second group, etc. Within each work group, subjects were randomly assigned to worker position. These groups were systematically distributed to attain mean PC equivalence across the four cells at each research site.[9] The 96 subjects at each site yielded 32 work groups, and eight groups were assigned to each of the four work flow interdependence–pay interdependence conditions.

5. Each subject was given feedback on his or her PC. Next, each read through a set of detailed written instructions specific to his or her experimental treatment and worker position. These instructions explained the work flow and how the subject's output and cash pay would be determined. Then the subjects were given new sets of triplets and translation keys and told to perform the task for a 45 minute production period.[10]

6. At the end of 45 minutes, each subject completed a post-experiment questionnaire containing manipulation check questions and other measures, then the experimental materials were collected. Pay was calculated and disbursed later.

RESULTS

Manipulation checks

Manipulation checks were performed for individualism, work flow interdependence and pay interdependence. The results indicated that these experimental manipulations did produce the intended relative effects.

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[8]This measure of performance capability is adopted from Chow (1983), Waller & Chow (1985), Chow et al. (1988) and Shields & Waller (1988). As Waller & Chow (1985, footnote 3) have observed, a potential limitation of this measure is that it "...captures a skill–effort combination rather than skill per se." It is important to recognize that in most real world tasks — including tests of intelligence — performance is necessarily jointly determined by an individual's skill and effort. To identify the unique contributions of skill and effort is difficult, if not impossible. Note that in the tests for performance effects, each subject's performance in the production period is normalized by his or her performance capability. To the extent that this measure of performance capability already includes some effort level, the tests relate to the marginal effects on effort of the experimental variables.

[9]Since administration of the experiment was highly labor-intensive (e.g. counting the number of triplets that each subject had correctly translated in the training period, assigning subjects to treatments and worker positions), the subjects at both sites were processed in several separate sessions. This permitted systematic rotation of subject assignment to treatment by performance capability (i.e. the top PC group was assigned to a different treatment at each administration, etc.) to attain pre-experimental equivalence across treatments.

[10]Sets of triplets different from those in the training period were used to control for potential confounding by learning.

TABLE 1. Cultural individualism[1]
(N = 96 for each mean)

Question	U.S. Mean	S.D.	Singapore Mean	S.D.	t =	P =
Leisure time[2]	1.65	0.68	1.98	0.63	3.52	0.001
Working conditions[3]	1.88	0.76	2.04	0.83	1.45	0.15
Cooperation[4]	2.02	0.68	1.68	0.66	3.56	0.001
Quality of living environment[5]	1.80	0.66	2.22	0.80	3.95	0.001

[1]Scale anchors: 1 = "of utmost importance"; 5 = "of very little importance."
[2]"Have sufficient time left for your personal or family life."
[3]"Have good physical working conditions (good ventilation and lighting, adequate work space, etc.)."
[4]"Work with people who cooperate well with one another."
[5]"Live in an area desirable to you and your family."

Individualism was measured using responses to the four questions in Hofstede's (1980) instrument. These questions asked each subject to indicate the importance to him or her of four job attributes: good physical working conditions, good interpersonal cooperation, leisure time and quality of the living environment. The five-point response scales were anchored by 1 = "of utmost importance" and 5 = "of very little importance". Table 1 presents the means and standard deviations of the Singapore and U.S. subjects' responses to the four questions.

According to Hofstede (1980), more importance being placed on good working conditions and good interpersonal relations implies a collective orientation, while a relative emphasis on leisure time and a good living environment implies an individualistic orientation. It should be noted that while these questions may appear oblique, Hofstede found that it was necessary to pose questions at this level of generality for people from radically different cultures to understand them.

Using factor and regression analyses, Hofstede (1980, 1982) developed weights for combining the four questions into an individualism scale, with a range of zero (low) to 100 (high). This scale yields one value for each cultural group, and has been used by Soeters and Schreuder

(1988) to test the relative effects of national vs organizational culture in CPA firms that operate in The Netherlands. The scores of our U.S. and Singapore samples on this scale were 55 and 31, respectively.

While the directional relation between the U.S. and Singapore subjects' individualism scores is as expected, the difference is much smaller than that reported in Hofstede (1980) (i.e. 91 for the U.S. vs 20 for Singapore). This result is due, at least in part, to the mean response to one of the four questions being contrary to the predicted direction. Table 1 shows that the U.S. subjects placed greater importance (smaller mean values) on leisure time and quality of living environment, while the Singapore subjects considered having good cooperation among workers more important than did the U.S. subjects. The directional difference between the two groups was highly significant for each question by a t-test (all P = 0.001; Table 1) and supported the ex ante classification of subjects. However, contrary to expectations, the U.S. subjects indicated that good working conditions were more important than did the Singapore subjects ($\bar{X}$ = 1.88 and 2.04, respectively). Even though this difference was not statistically significant (P = 0.15), it still reduced the difference between the two groups' scores on the combined scale.[11]

[11]Hofstede (1980) showed that on 5-point "importance" scales, the countries in his study exhibited "acquiescence" effects (i.e. consistently scoring every item as being less or more important), and that this effect is negatively correlated with cultural individualism. This effect is not reflected in Table 1. In fact, the average response of the more individualistic U.S. subjects to the four items (1.84) was lower than that for the more collectivist Singaporeans (1.98). Adjusting for the acquiescence effect (deducting the difference of 0.14 points from the Singaporean scores) does not affect the conclusions about the difference between the two groups. However, the difference on "working conditions" becomes even less significant (1.88 vs 1.90).

One potential explanation for this result is that the student subjects had only partially developed their work-related values.

The work flow and pay interdependence manipulations were tested by examining responses to two statements, "I was able to produce a complete unit of output by myself," and "My pay was dependent on the performance of the other two workers in my department." Both seven-point response scales were anchored by 1 = "very inaccurate" and 7 = "very accurate". The mean response to the former statement was significantly higher for the independent work flow subjects than for the dependent work flow subjects ($\bar{X} = 5.94$ and 3.00, respectively; $t = 9.75, P < 0.001$). The mean responses to the second statement also differed significantly between the dependent and independent pay conditions in the expected direction ($\bar{X} = 5.43$ and 2.96, respectively; $t = 8.28$, $P < 0.001$). These results suggest that both interdependence manipulations were successful.

Descriptive statistics

Table 2 presents descriptive statistics by cell for the variables used in the hypothesis tests; Table 3 presents descriptive statistics by cell averaged over worker position. Table 4 contains a correlation matrix for PC, work experience, cultural individualism, and absolute and normalized performance. There was a marginally significant difference between the mean PCs of the high and low individualism subjects ($\bar{X} = 221$ and 212, respectively, $t = 1.80, P = 0.07$). To control for performance differences due to this preexperimental difference,[12] each subject's absolute performance (i.e. number of triplets translated in the 45 minute production period) was normalized by his or her PC in the hypothesis tests. Table 2 shows that both mean absolute performance and normalized performance had considerable between-cell differences.

The subjects' self-reported years of full time equivalent work experience had a mean for the high individualism subjects of 3.53 as compared

to 0.95 for the low individualism subjects. Since these means were significantly different ($t = 7.12, P < 0.001$), years of full time equivalent work experience was included as a covariate in the hypothesis tests.

Hypothesis tests

H1 was tested with the entire sample. Subsets of the sample were used to test the four directional hypotheses.

Tests of H1. An analysis of all the subjects' data was conducted using a 2^3 by 3 between-subjects ANCOVA [Keppel, 1982]. Normalized performance was the dependent variable, years of work experience was the covariate, the dichotomous independent variables were cultural individualism, work flow dependence and pay system dependence, and worker position had three levels.

Table 5 shows that the overall model was significant ($F = 1.93, P = 0.009$), and that the effect due to the work experience covariate was not significant ($P = 0.25$). The three-way interaction among individualism, work flow interdependence and pay interdependence was not significant ($F = 1.47, P = 0.227$). The two-way interactions between individualism and either work flow or pay interdependence were also not significant ($P = 0.21$ and 0.41, respectively). Thus, the first explanation of the Asian firms' superior manufacturing performance was not supported.

Both the second and third explanations of the Asian firms' manufacturing performance were partially supported. As Table 5 indicates, there were significant main effects due to cultural individualism, pay interdependence and worker position, though not for work flow interdependence. In addition, two interactions — work flow interdependence by pay interdependence and work flow interdependence by worker position — were marginally significant. Below, the only effect interpreted is cultural individualism. The other significant main effects were also part

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[12]Controlling for performance capability is important because prior studies using a similar task have found that actual performance is significantly related to this subject attribute (Waller & Chow, 1985; Chow et al., 1988).

TABLE 2. Cell means and standard deviations
($N = 8$ for each cell)

Cultural individualism — Low

		Independent						Dependent					
Work flow		Independent			Dependent			Independent			Dependent		
Pay		Independent			Dependent			Independent			Dependent		
Worker		1	2	3	1	2	3	1	2	3	1	2	3
Work experience (years)	X̄	2.63	1.03	0.95	0.90	1.02	0.31	1.16	1.52	0.48	0.16	0.35	0.86
	S	4.09	1.04	0.68	1.18	0.98	0.40	1.27	1.40	0.94	0.14	0.26	0.86
Performance capability (PC)	X̄	209.38	206.00	200.25	212.38	209.00	217.63	209.13	206.75	197.25	226.63	228.00	225.75
	S	24.21	27.10	32.01	26.60	30.25	26.47	35.89	31.36	37.98	32.33	30.67	29.59
Absolute performance	X̄	822.00	859.38	694.00	805.00	820.88	706.13	791.13	750.75	698.38	839.75	810.38	780.13
	S	98.98	102.50	134.70	147.90	115.68	91.26	157.13	112.39	124.03	116.27	112.20	126.24
Normalized performance	X̄	3.96	4.20	3.50	3.85	3.98	3.29	3.85	3.67	3.56	3.75	3.58	3.46
	S	0.57	0.47	0.78	0.92	0.67	0.60	0.94	0.58	0.33	0.66	0.53	0.43

High

Independent						Dependent					
Independent			Dependent			Independent			Dependent		
1	2	3	1	2	3	1	2	3	1	2	3
3.41	4.31	3.22	5.00	5.37	2.03	1.69	2.31	2.69	4.59	4.06	3.74
2.78	1.62	2.46	4.65	6.50	2.10	1.34	2.31	2.20	3.15	3.43	2.16
219.75	225.88	219.50	217.75	215.88	220.13	223.88	224.00	233.63	223.88	221.88	217.38
39.35	44.87	33.70	45.45	36.27	31.54	40.39	41.58	43.68	38.13	36.76	35.71
796.75	904.88	781.75	715.13	747.63	663.63	820.25	803.50	749.00	803.13	794.63	746.00
159.08	210.96	133.21	197.64	207.78	171.92	112.08	138.12	136.10	196.79	197.81	209.54
3.62	4.00	3.57	3.25	3.43	2.99	3.70	3.60	3.36	3.56	3.55	3.39
0.31	0.58	0.42	0.39	0.59	0.48	0.35	0.28	0.14	0.34	0.44	0.52

TABLE 3. Marginal means and standard deviations
(averaged over worker position)

Cultural individualism		Low				High			
Work flow		Independent		Dependent		Independent		Dependent	
Pay		Independent	Dependent	Independent	Dependent	Independent	Dependent	Independent	Dependent
Absolute performance	X̄	791.79	777.33	746.75	810.08	827.79	708.79	790.92	781.25
	S	130.13	126.31	132.45	115.82	172.59	187.81	127.41	194.21
Normalized performance	X̄	3.89	3.71	3.70	3.60	3.73	3.22	3.55	3.50
	S	0.65	0.77	0.65	0.54	0.47	0.51	0.29	0.43

TABLE 4. Pearson correlations
(significance level if $P < 0.10$)
($N = 192$)

	Work experience	Cultural individualism	Absolute performance	Normalized performance
PC	0.03	0.01	0.67 (<0.001)	−0.19 (0.005)
Work experience		0.18 (0.007)	−0.03	−0.08
Cultural individualism			−0.03	−0.07
Absolute performance				0.59 (<0.001)

TABLE 5. ANCOVA results for normalized performance

Effects	df[1]	F	P
Model		1.93	0.009
Culture (C)	1	5.43	0.021
Work flow (WF)	1	0.47	0.496
Pay (P)	1	6.97	0.009
Worker Position (WP)	2	8.09	<0.001
C × WF	1	1.55	0.215
C × P	1	0.67	0.413
C × WP	2	0.51	0.599
WF × P	1	3.08	0.081
WF × WP	2	2.64	0.074
P × WP	2	0.04	0.963
C × WF × P	1	1.47	0.227
C × WF × WP	2	0.47	0.624
C × P × WP	2	0.00	0.998
WF × P × WP	2	0.24	0.786
C × WF × P × WP	2	0.07	0.935
Work experience	1	1.35	0.247

[1]Numerator df; denominator $df = 167$.

of significant interactions, and main effects should not be interpreted as indicating linear effects when significant interactions exist (Neter and Wasserman, 1974).

The significant ($F = 5.43$, $P = 0.02$) cultural individualism main effect is due to the lower individualism subjects having a higher level of normalized performance ($\bar{X} = 3.72$ vs 3.50). While this result is consistent with performance being directly affected by national culture, this interpretation is subject to two caveats. First, even though pay per unit of output was varied between the two research sites to make them equivalent relative to the local pay scale (see footnote 6), strict equivalence still may not have been attained.[13]

Second, the normalizing procedure may have introduced a bias against the high individualism subjects. Recall that the individual PCs were obtained by having each subject perform the translation task by himself or herself. Given that the PC session was individualistic in nature, the high individualism subjects may have performed at a higher level than the low individualism subjects. In turn, normalizing each subject's absolute performance by his or her PC could have depressed the high individualism subjects' performance measures relative to those of the low individualism subjects.[14]

The marginally significant ($F = 3.08$, $P = 0.08$) interaction between work flow and pay interdependence is consistent with the contingency view that the fit among elements of a con-

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[13]There is indirect evidence that our attempt to equalize the pay scales was successful. The exit questionnaire asked each subject to indicate his or her satisfaction with his or her total pay for the work performed. The seven-point scale was anchored by 1 = "very satisfied" and 7 = "very dissatisfied." The Singapore and U.S. samples did not have significantly different mean responses (3.82 and 3.84, respectively; $t = 0.08$, $P = 0.93$).

[14]Recall that each subject's own PC was used to normalize his or her absolute performance. If absolute performance had been used as the dependent variable, the results would have been confounded by the rather substantial interpersonal PC differences. While normalizing may have potentially biased the individualism main effects in all the hypothesis tests that used both the U.S. and Singapore subjects, it was unlikely to have affected the interaction effects. Consider the following example. Assume that in the PC session, the high individualism subjects had performed at a level of 100 while the low individualism subjects had performed at 80 (due to different degrees of "fit" with the nature of the task). Further, assume that in the experimental session, the high individualism subjects who had been assigned to a dependent (independent) condition had performed at 90 (100), while the corresponding low individualism subjects had performed at 90 and 80, respectively. In this example, even though the high individualism subjects had a higher mean level of absolute performance, their normalized performance would be lower than that of the low individualism subjects (0.95 vs 1.05). However, for both the high and low individualism subjects, the subgroup which had the better "fit" with the dependency condition would still show a higher level of normalized performance (1.0 vs 0.9 for the high individualism subjects; 1.1 vs 1.0 for the low individualism subjects). Note also that since the subjects were not paid in the PC session, neither the main nor interaction effects for the pay dependency treatment was likely to have been affected. It can be readily shown that if a group task had been used in the PC session, then the normalizing procedure would have introduced a potential bias against the low individualism subjects instead. In either case, a biased mean level of normalized performance for the entire sample would have inflated the variance and reduced the power of that statistical tests. In hindsight, PC sessions perhaps could have been conducted using both individual and group tasks, and each subject's performance averaged across them.

trol system affects performance. When independent pay was matched with independent work flow, normalized performance was higher ($\bar{X}$ = 3.81) than when it was matched with dependent work flow ($\bar{X}$ = 3.62). Similarly, normalized performance was higher when dependent pay was matched with dependent work flow ($\bar{X}$ = 3.55) than when it was matched with independent work flow ($\bar{X}$ = 3.47).

The marginally significant (F = 2.64, P = 0.07) interaction between work flow dependence and worker position is caused by there being different patterns of means over workers for work flow dependence and independence. When work flow was independent, the second worker's normalized performance was the highest of the three workers ($\bar{X}$ = 3.67, 3.90 and 3.34, respectively). The data that were collected did not permit an analysis of how this result may have come about. A potential explanation is that the second worker was subject to greater non-pecuniary motivational effects (e.g., competition) due to having reference points on both sides.[15]

When work flow was dependent, normalized performance decreased across worker position ($\bar{X}$ = 3.71, 3.60 and 3.44, respectively). While these different patterns are consistent with work flow interdependence having a motivational effect, such an interpretation may be premature. Recall that under the dependent work flow condition, it was not possible for a worker to perform higher than the preceding worker. The declining mean normalized performance across worker positions under dependent work flow is consistent with such a physical constraint being operative.

To control for the constraining effects of work flow dependence on output, we performed two reduced form ANCOVAs using different subsets of the sample. The results were not qualitatively different from those reported above. The first ANCOVA excluded the dependent work flow condition to test the effects of cultural indi-

vidualism and pay interdependence with all three workers. This ANCOVA model was significant (F = 2.86, P = 0.002); all three main effects were significant but none of the interactions was significant (P > 0.10). As before, cultural individualism was significant (F = 5.61, P = 0.02), with the low individualism subjects outperforming the high individualism subjects ($\bar{X}$ = 3.80, 3.48). Normalized performance was significantly higher when pay was independent than when it was dependent ($\bar{X}$ = 3.81, 3.47; F = 8.31, P = 0.005). The worker position effect was also significant (F = 7.23, P = 0.001), with worker two having the highest normalized performance ($\bar{X}$ = 3.67, 3.90, 3.34, respectively).

The second ANCOVA retained the dependent work flow condition but only included worker one (whose output was not constrained by that of other workers in the group). This reduced-form ANCOVA model was not significant (F = 0.92, P = 0.51). There was only one significant effect, cultural individualism (F = 9.91, P = 0.05), again with the low individualism subjects having a higher normalized performance ($\bar{X}$ = 3.85, 3.53).

Tests of H2–H5. Inferential tests of H2–H5 were performed using several reduced-form models of the complete 2^3 by 3 between-subjects ANCOVA. In each of these ANCOVAs, normalized performance was the dependent variable, years of work experience was the covariate, and the independent variables were worker position with three levels and various combinations of the three dichotomous factors — cultural individualism, work flow interdependence and pay interdependence. For all but one of these ANCOVAs, the worker position main effect was significant (P < 0.05); the effect was marginally significant (P < 0.10) for that one exception. Worker position was not involved in any interaction effects (P < 0.10).

H2 predicted that workers with a low individualistic cultural orientation perform higher

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[15] In all conditions at both research sites, worker three had both the lowest mean absolute and normalized performance. This result is explainable for the subjects in a dependent work flow condition; its persistence in the independent work flow condition is puzzling since the subjects had been randomly assigned to worker position.

when work flow and/or pay are dependent, and lower when work flow and/or pay are independent. This prediction was tested with a 2 by 2 by 3 ANCOVA using only those subjects in the low individualistic culture condition. Work flow, pay, and worker position were the independent variables. Mean normalized performance was lower with a dependent vs independent work flow ($\bar{X} = 3.65$ vs 3.80) and dependent vs independent pay system ($\bar{X} = 3.65$ vs 3.79), though neither mean difference was significant ($F(1,83) = 1.60, P = 0.21; F(1,83) = 1.55, P = 0.22$, respectively). Hence, H2 was not supported.[16]

H3 predicted that workers with a high individualistic cultural orientation perform higher when work flow and/or pay are independent, and lower when work flow and/or pay are dependent. This prediction was tested with a 2 by 2 by 3 ANCOVA which included only those subjects in the high individualistic culture condition. Work flow, pay, and worker position were the independent variables. The interaction between pay and work flow was significant ($F(1, 83) = 6.85, P = 0.01$). Mean normalized performance was highest when both pay and work flow were in the independent condition ($\bar{X} = 3.73$). Consistent with H3, when pay was independent, mean normalized performance was higher with independent vs dependent work flow ($\bar{X} = 3.73$ vs 3.55). However, when pay was dependent, mean normalized performance was higher, rather than lower, when work flow was dependent vs independent ($\bar{X} = 3.50$ vs 3.22). Thus, H3 was only partially supported.

H4 predicted that when there is work flow and/or pay dependence, workers with a low individualistic cultural orientation out-perform workers with a high individualistic cultural orientation. This prediction was tested with two separate 2 by 3 ANCOVAs using only subjects in the work flow or pay dependence conditions. Cultural individualism and worker position were the independent variables. When pay was

dependent, the low individualism subjects had a significantly higher mean normalized performance ($\bar{X} = 3.65$ vs $3.36; F(1, 89) = 4.25, P = 0.04$). Their mean normalized performance was also higher when work flow was dependent, though this difference was not statistically significant ($\bar{X} = 3.65$ vs $3.53; F(1, 89) = 0.37, P = 0.54$). These results provide partial support for H4.

H5 predicted that when there is work flow and/or pay independence, workers with a high individualistic cultural orientation outperform workers with a low individualistic cultural orientation. This prediction was tested with two separate 2 by 3 ANCOVAs using only the subjects in the work flow or pay independence conditions. Cultural individualism and worker position were the independent variables. When pay was independent, the high individualism subjects had a lower, rather than higher, mean normalized performance, though this difference was not statistically significant ($\bar{X} = 3.64$ vs $3.79; F(1, 89) = 1.66, P = 0.20$). When work flow was independent, the high individualism subjects had a significantly lower mean normalized performance ($\bar{X} = 3.48$ vs $3.80; F(1, 89) = 5.16, P = 0.03$). These results are contrary to H5.

SUMMARY AND DISCUSSION

An important question being asked today is whether the management control systems of Asian manufacturing firms can be used by non-Asian firms to improve their manufacturing performance. Answering this question requires consideration of differences between the Asian and non-Asian firms in their employees' national cultures, their countries' economic and political infrastructures, as well as their management control systems. Given the complexity of this issue and the dearth of extant research, this study conducted a laboratory experiment to

[16] To control for the physical constraining effects of the dependent work flow condition, the ANCOVAs for all four directional hypotheses were also conducted by using either only the subjects in the dependent work flow condition, or only worker one. The results were not qualitatively affected.

provide some formal evidence on the question while not overwhelming the project with factors that are important but tangential to the immediate focus. The extant theoretical and empirical literatures provided the basis for five hypotheses to guide this exploratory study.

The results of testing H1 indicated that national culture and management controls had independent, but not interactive, effects on performance. (Recall, however, that the result for national culture was subject to two important caveats. See footnotes 13 and 14.) Considering only the management control system, performance increased as the fit between pay and work flow interdependence increased (i.e. both elements were either independent or dependent).

The evidence relating to the four directional hypotheses was mixed. H2 was rejected because subjects with a low individualistic cultural orientation were not found to perform higher when the control system induced interdependencies among the workers in a group. H3 was only partially supported for the high individualism subjects because of an interaction between pay and work flow. With a dependent pay system, performance was higher when there was an independent work flow. However, with an independent pay system, performance was higher with a dependent work flow. The evidence also provided partial support for H4. When pay was interdependent among workers, the low individualism subjects outperformed the high individualism subjects. Finally, H5 was not supported. The high individualism subjects did not outperform the low individualism subjects under either independent work flow or pay.

These results have two potentially important implications for the design of management control systems. First, they do not refute the possibility of a specific system being effective in highly diverse national cultures. Second, irrespective of national culture, interdependencies induced by the control system among employees affected performance. It is important to note, however, that making such generalizations to practice is premature.

First, as was pointed out earlier, all research studies are affected by the cultural predisposition of the researchers, subjects and readers. While this study has attempted to minimize this bias, some probably remains. To reduce this problem in the design and conduct of studies, future research should, for example, use cross-cultural research teams. Beyond this, multiple research methods should be used to detect any remaining bias.

Second, like all experimental research, the results of this study are functions of the specific experimental task, subjects and parameter values. The robustness of the findings needs to be tested against variations in these aspects of the experiment. For example, using subjects who have more work experience or managerial (instead of assembly-line) tasks may increase the ability to detect the effects of work-related cultural characteristics. Lengthening the experimental session may increase the chances of obtaining steady state effects. In addition to measuring total output, future research should include other dimensions of performance such as quality. Future research could also use a task that allows for more unconstrained interaction within work groups. It is also desirable to expand the scope of the empirical investigation to include field and survey studies.

There are at least two major directions for future research on culture and management controls. First, focusing on national culture, Hofstede (1980) has found considerable variation across countries in other cultural predispositions of workers. For example, there is variation in workers' uncertainty avoidance. Since this cultural predisposition may affect risk taking behavior, research could be undertaken to examine its effects on controls designed to encourage decisions and actions that have particular risk (e.g. innovation, change) or temporal (e.g. long-term investments) characteristics. Hofstede has also reported wide variation across countries in workers' predispositions towards power distance, which is the extent to which workers accept inequality in vertical social relations (e.g. superior-subordinate). Whether this cultural tendency affects the most effective level of decentralization and participation in

management control systems is worthy of investigation. Second, as pointed out by Soeters and Schreuder (1988), research into how management controls, national culture and organizational culture independently and interactively affect performance would also be valuable.

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